



OFFICE OF ENERGY EFFICIENCY
AND RENEWABLE ENERGY



Home Lighting Energy-Saver Detective



Grade 4-7



OFFICE OF BUILDING TECHNOLOGY,
STATE AND COMMUNITY PROGRAMS

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Home lighting energy-saver detective student pages

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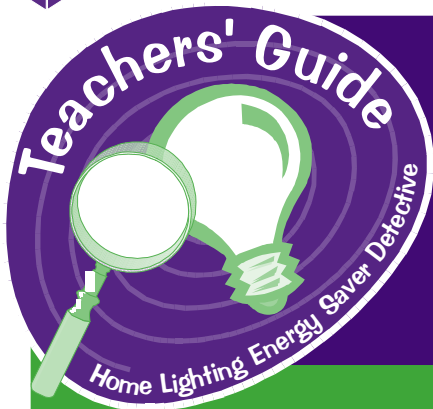
Transparency Masters

Electricity production from fossil fuels	17
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Overview

The U.S. Department of Energy promotes energy efficiency because electricity generation contributes to air pollution—including 35% of U.S. emissions of carbon dioxide (CO₂). American homes contain over 3 billion light fixtures which use approximately 138 billion kilowatt-hours of energy per year—between 6% to 10% of the total residential electricity use. The Home Lighting Energy Saver Detective activities invite students to discover the impact that a simple act of changing a light bulb can have on the environment, American energy consumption, and their family's home utility bill. A "home lighting energy-saver detective scientific investigation" is used to guide the students through a logical progression of discerning fact and opinion and solving real-life mysteries.

Levels:

Grades 4-7

Subject:

Real-life applications of mathematics, science, social studies, and scientific investigations

Concepts:

- Relationship between reducing energy use, a better environment, and a lower utility bill
- Students will understand the positive outcomes of using energy-efficient compact fluorescent lights (CFLs)
- Distinction between science and technology with regards to lighting, electricity, energy, global climate change and other key terms in the glossary

Skills:

Problem solving via a scientific investigation, observation, interpretive thinking, multiplication, division, and word problems

Objectives:

- Students will understand how to use a scientific investigation to make decisions that cut costs, save energy, and help the environment.

Time Considerations:

- 3 Class Periods

Materials:

- Teachers' Guide sheets (pp. 1,2,3,5,7,8,14)
- Energy, environment and scientific investigation in-class instruction materials (pp. 17-28)

(continued next page)

Approach

These activities and lesson plans are designed to teach children about energy-efficient technology and the economic and environmental benefits discovered through science and mathematics. Each activity includes a 1-2 page teachers' guide and reproducible student page(s). Page 28 features a preview of all student pages. The appendix contains a glossary (p. 29-30), an energy-efficient compact fluorescent lamp or light (CFL) fact sheet (p. 31), and background information on energy and the environment in the form of reproducible in-class instruction sheets suitable for transparencies or student hand-outs (pp. 17-27) and extension activities (p. 32).

The activities are designed to work together; and they follow a logical progression used in many scientific investigations. The activities are designed to be taught to students in one or more subject areas to enhance student understanding in the relationship that math, science, and social studies have in solving real-life mysteries. The assessment and extension activities are based on a wholistic understanding of scientific investigations and the key concepts associated with each activity.

Assessment opportunities

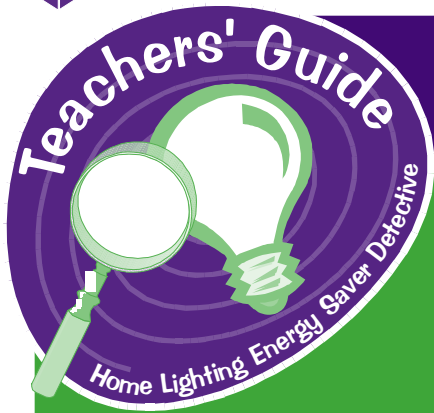
1. Create a quiz with questions about the key concepts referenced on each of the teachers' main guide pages for each lesson and the terms in the glossary.
2. Ask groups of students to conduct scientific investigations designed to answer broader questions from the energy-saving clue sheet (p. 27) such as:
 - a. Could the students in your class, grade, or school save enough energy in a year to put the space shuttle in orbit by replacing their incandescent light bulbs with energy-efficient CFL light bulbs?
 - b. If the entire class, grade, or school replaced all the light bulbs in their home with compact fluorescent light bulbs (CFLs), would they prevent pollution equivalent to the pollution eliminated by removing a car from the road?
 - c. If the entire class, grade, or school replaced all the lights in their home with CFLs could they save enough money in energy costs to pay for a new playground? Computer lab? Library? Class trip to Disney World and Epcot Center? Snowboard? New bike?

Applicable Education Standards

The U.S. Department of Energy's Office of Building Technology, State and Community Programs designed these lessons as supplements to current science and math curriculums. They are designed in accordance with many of the objectives of the National Science Education Standards, A, E, F and G described below and continued on the next page.

1. Content Standard A - abilities necessary to understand and do a scientific inquiry, including:

- Identify questions that can be answered through a scientific investigation
- Design and conduct a scientific investigation
- Use appropriate tools and techniques to gather, analyze, and interpret data
- Develop descriptions, predictions, and models using evidence
- Think critically and logically, and make the relationships between evidence and explanations



Materials (continued):

- Glossary (p. 29-30)
- Compact Fluorescent Light (CFL) fact sheet (p. 31)
- Extension Activities (p. 32)
- Home Lighting Energy-Saver Detective student pages:

Research: How much energy do my lights use? (p. 4)

Hypothesis: What will happen if I use less energy? (p. 6)

Analysis: How much can I save? (pp. 9-12)

In-class Analysis: How much air pollution can our class prevent by using CFLs? (p. 13)

Conclusion: Was my hypothesis about energy saving and pollution prevention correct? (pp. 15-16)

Contact Information:

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2. Content Standard E - developing student abilities and understanding of science and technology:

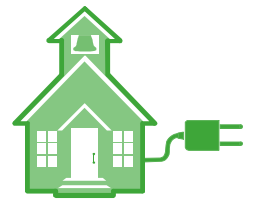
- Work with scientific investigations to meet a human need or solve a human problem
- Design and implement a solution
- Evaluate completed technological designs or products

3. Content Standard F - understanding personal health, populations, resources, and environments, natural hazards, risks and benefits and science and technology in society:

- Science helps drive technology
- Introduction of large abstract environmental issues like acid rain and global warming
- Understanding human activities can also induce hazards through resource acquisition, land-use issues, and waste disposal
- Technology influences society through its products and processes

4. Content Standard G - understanding science as a human endeavor

- The work of science relies on basic human qualities such as reasoning, insight, energy, skill, and creativity
- Scientists formulate and test their explanations using observation, experiments, and theoretical and mathematical models



Key Term Glossary

Acid rain: When sulfur dioxide and nitrogen oxides are emitted from cars and power plants, they mix with water vapor and turn into acids, which in turn, fall to the ground with rain, snow, or fog. This “acid rain” corrodes buildings, damages trees, harms vegetation and can harm or destroy aquatic life.

AMPERE (AMP): The measure of the number of electrons flowing through a wire. If electricity were water in a flowing river, the amps would be the amount of water flowing in that river. (See volt and watt.)

Analysis: An examination of a system, its elements, and their relations; or proof of a mathematical proposition by assuming a result and deducing a valid statement by a series of reversible steps as in the Scientific Method.

Ballast: A device that charges the electrical current in fluorescent lights.

Biomass: Farming wastes, grasses, trees, bark, sawdust, and other things which can be changed into energy by burning it, changing it to a gas, or by converting it to a liquid fuel

Boiler: A pressurized vessel in which water or another liquid is heated to generate steam energy.

Carbon Dioxide (CO₂): A gas that is the product of burning fossil fuels and contributes to the greenhouse effect. It is also a naturally occurring chemical that is absorbed by plants. The molecule CO₂ has one carbon atom and two oxygen atoms.

Coal: A solid fossil fuel found in the earth that is often burned to make electricity.

Compact fluorescent lights or lamps (CFL): Fixtures that contain gas instead of wire filaments. Electrical current makes the gas atoms glow or “fluoresce.” This fluorescence creates light with very little heat. (Note: In this lesson CFL is sometimes referred to as light due to audience knowledge levels.)

Conservation: Protecting something from waste, loss, or harm. Energy conservation means using less energy, both by using more energy-efficient technologies and by changing wasteful habits.

Efficiency: The amount of work you get for the energy you use. An energy-efficient light bulb uses most of its energy to create light, not heat. An efficient power plant gets more electricity out of the coal or oil it burns and less unwanted heat or pollution.

Electricity: One of the most important forms of energy, consisting of oppositely charged electrons and protons that produce light, heat, magnetic force, and chemical change.

Energy: The product of power (watts) and time (hours) or the capacity for doing work. Energy used for lighting can be saved by either reducing the amount of power required to produce the same amount or more light (lumens).

Energy-efficiency: Getting more accomplished with less energy.

Energy-efficient lighting: Lights that produce the same amount of light (lumens) using less electricity (watts) than conventional light bulbs. Efficient lights are usually fluorescent (they don’t waste energy making unwanted heat), and they may have reflectors that direct the light where you want it.

ENERGY STAR® labeled products:

Products which have met the specifications of a joint program of the U.S. Department of Energy and the U.S. Environmental Protection Agency for energy efficiency and pollution prevention.



Fossil Fuels: Fuels such as oil, coal and natural gas, that formed millions of years ago from decayed plants and animals that contain carbon.

Fuel: A material (liquid, solid, or gas) that can be used to provide power for an engine, power plant, or nuclear reactor.

Generator: A machine that converts mechanical energy into electrical energy.

Geothermal energy: Using the heat from the earth to produce power

Global Warming: Possible accelerated increase in the Earth’s temperature caused by excess production of greenhouse gases due, in large part, to the depletion of forests, air pollution from automobiles, making electricity via fossil fuels and burning fossil fuels for other needs.

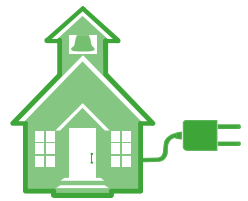
Greenhouse Effect: The trapping of the sun’s heat. In houses and cars it can be caused by glass. In the Earth’s atmosphere it is a naturally occurring phenomenon resulting from the interaction of sunlight with greenhouse gases (such as CO₂ and CFCs). This interaction helps maintain the delicate balance of temperature and breathable air necessary for life as we know it.

Halogen torchiere: A popular, indoor, contemporary floor lamp. This light bulb uses 300-500 watts and has been identified as a potential fire hazard due to the excessive heat (750 -1000 degrees F) generated from the light produced.

Hydropower: Using the energy in flowing water to make electricity.

Hypothesis: Educated guess and step 3 in the Scientific Method.

Incandescent light bulbs: Light bulbs that work on the principle of electrical resistance. Electrical current flows through a wire filament, which slows or “resists” the flow of electrons. The wire gets hot and glows. Thus the incandescent bulbs create both heat and light.



Key Term Glossary (continued)

Kilowatt: 1,000 watts

Kilowatt-hour: The amount of work that can be done by one kilowatt during one hour.

Lumens: The measure of the amount of light a bulb puts out.

Natural gas: A fossil fuel found deep in the earth—often in oil.

Nonrenewable Energy: Sources of energy that will run out such as coal, gas, oil, nuclear energy, and hydropower.

Oil: A liquid fuel found deep in the earth, which is often used to make electricity, gasoline and other products.

Passive solar house: A house that uses a room or another part of the building as a solar collector.

Photosynthesis: The process by which plants make their own energy. Plants use energy from the sun to convert carbon dioxide (gas) and water into carbohydrates (simple sugars). One of the by-products of photosynthesis is oxygen, which is used by people and other animals to breathe. As animals use energy, they exhale carbon dioxide gas, which can be absorbed up by the plants and used for photosynthesis.

Power: The ability to do or act and or the time rate at which work is performed.

Renewable Energy: Sources of Energy that will not run out, such as sun, wind, wood, biomass, and water.

Science: The organized body of knowledge that is derived from observations and can be independently verified or tested by further investigation.

Scientific Method: An organized approach to problem solving that includes collecting data, formulating a hypothesis, testing it objectively, interpreting results, and stating a conclusion that can later be independently evaluated by others.

Steam Turbine: A machine in which high-pressure steam is made to do work by acting on and rotating blades in a cylinder. Steam turbines are used in the majority of power plants that use fossil fuels to produce electricity.

Solar collectors: Boxes, frames, or rooms that trap the sun's rays to produce heat.

Solar energy: Energy from the sun (i.e. the heat that builds up in your car when it is parked in the sun).

Sulfur Dioxide (SO₂): A toxic, colorless gas which is a dangerous constituent of smog. It is formed by volcanic activity, organic decay and burning of fossil fuels.

Technology: The application of scientific know-how for practical purposes or any use of objects by humans to do work or otherwise manipulate their environment.

Volt: The measure of the force of an electrical current. If electricity were a river, the voltage would be the speed of the water's current. (See amp and watt.)

Waste to energy: Trash or methane gas from decaying food products that are burned to create steam for electricity production.

Watt-hours: The amount of work that can be done by one watt in one hour.

Watt: The measure of electric power produced. One amp multiplied by one volt equals one watt. If electricity were a river, the watts would be the amount of work the water's current could do. (See amp and volt.)

Wind power: Using the wind to produce electricity by turning blades on a wind turbine.

Wind power plant: a group of wind turbines interconnected to a common utility system.

HOW TO GET CFLs

Saving energy by replacing light bulbs



Screw-in compact fluorescent lamps (CFLs) are a high efficiency, direct substitute for common light bulbs. They use $\frac{1}{4}$ the electricity, last up to 10 times longer, and provide comparable light quality. CFLs are most cost-effective when used in applications having long operating hours such as exterior lights, ceiling fixtures, and most frequently used table and floor lamps. Some CFLs even have dimming capability.

CFLs are now widely available from most stores that typically sell common light bulbs, especially hardware stores and mass merchandisers. Exceptions are some supermarkets, drug stores, and small grocery stores, many of which do not yet carry CFLs. In addition, CFLs are available through lighting suppliers, some catalogs, and through several web sites.

Prices vary widely as due CFL lengths, rated lifetime hours, and available wattages. For example, prices range from \$6 to over \$30 for CFLs of identical wattage. Also, some CFLs come with warranties stated on the package and others do not. So, it pays to shop carefully for the best price and to ask your supplier about the warranty.

A new type of screw-in CFL is just reaching the market through a DOE sponsored program. The new CFLs are smaller, brighter, and lower cost when compared to many currently available products. We call these new CFLs "sub-compact" or "sub-CFLs". The new sub-CFLs are only beginning to appear in stores but should be widely available within the year.

Stores Known to Carry CFLs:

Home Depot
HomeBase
K-Mart
Sears
Wal-Mart
Price-Costco
IKEA
Lowes Home Improvement
Target

Catalogs Known to Carry CFLs:

Real Goods	1-800-762-7325
Maintenance USA	1-800-283-4000
Maintenance Warehouse	1-800-431-3000

DOE Sub-CFL Volume Purchase Vendors:

The minimum purchase is 6 to 10 Sub-CFLs. All sub-CFLs in this program come with a 1 year, no-cost, warranty. Product descriptions, pricing, and order forms can be found at

<http://www.energystar.gov/volumepurchase.html>

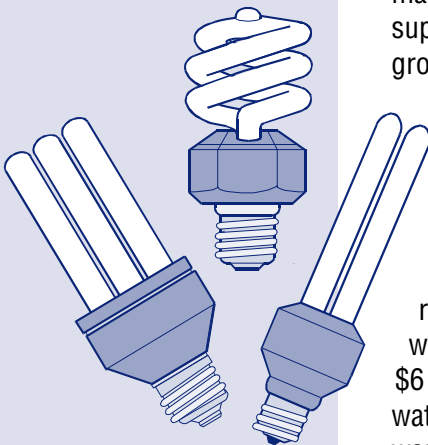
or call any supplier at the numbers below.

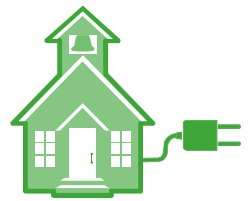
Duro-Test Lighting	1-800-BUY-DURO
Lights of America	1-800-478-6775
Sunpark Electronics	1-888-478-6775

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Home Lighting Energy Saver Detective Appendix

Extension Activities

1. Ask the students to research the readily available energy saving opportunities described on the Energy Star web page (<http://www.energystar.gov>). Use this information to design a home or apartment with the lowest impact on the environment.
2. Consider the following topics for an essay contest, class debate, or school display:
 - Nonrenewable vs. renewable energy
 - Science vs. technology aspects of energy-use
 - Prominent inventors and users of electricity and energy (Ben Franklin, Thomas Edison, Albert Einstein, James Watt)
 - Retrieve and execute the other energy efficiency education activities and information from Energy Smart Schools Earth Day page at
 - <http://www.eren.doe.gov/buildings/earthday/>
 - <http://www.eren.doe.gov/buildings>
 - www.nrel.gov/business/education
 - www.eren.doe.gov/kids.html
 - Assign an Internet research project designed to find, analyze, and offer opinions about other school and home energy efficiency projects.
 - Hold an energy awareness month (download a copy of this document from the Fact Sheet hot button on BTS's Earth Day page: <http://www.eren.doe.gov/buildings/earthday/>).
 - Bring in examples of readily available compact fluorescent lights (CFLs) and demonstrate the replacement choices.
 - Consider selling CFL light bulbs at a school fund-raiser; set a goal to sell enough CFLs to meet one of the goals outlined in assessment activity 2C (see page one.) Students could design their own sales advertisement or commercial to demonstrate how well they grasped the concepts taught in the lesson.
 - Engage the students in a full life-cycle cost analysis of energy-efficient lighting vs. less efficient incandescent lighting.

Credits

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American Forest Foundation. (1995). "Energy Sleuths." Project Learning Tree Environmental Pre K-8 Education Activity Guide. pp. 126-130.

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